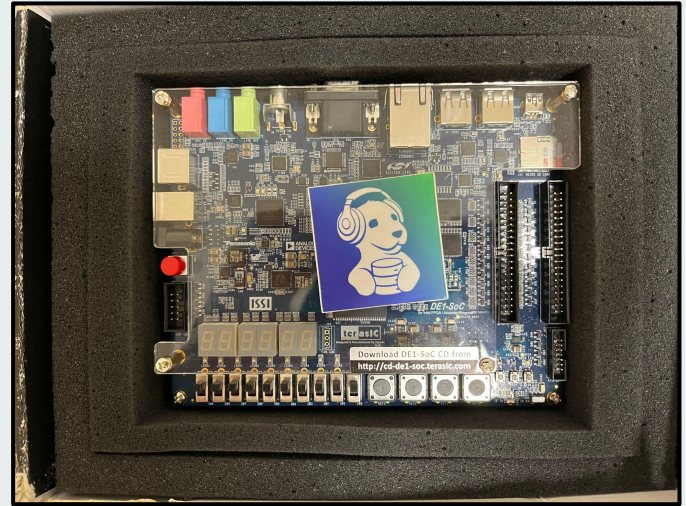




FPGA DJ



Joy He, Oliver MacGregor, Harrison Riley, Joshua Zhou



What we have

- The FPGA DJ can play two songs simultaneously
- Playback and effects are controlled by the keyboard
- Play/pause, skip around songs, loop songs
- Gain, echo, low pass/high pass filtering, airhorn



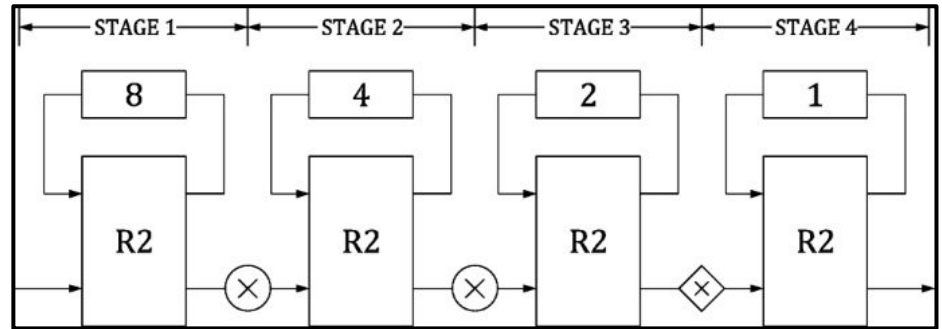
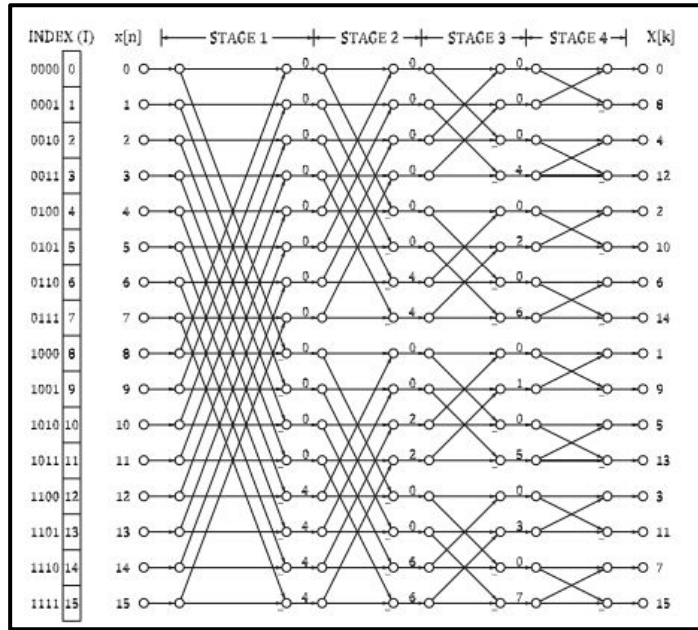
Behind the scenes 🎪

- Hardware FFT & IFFT to apply frequency domain effects
- Audio interface
 - Qsys
 - FIFOs to hold data and signal when codec is busy or free
- Hardware-software interface
 - Device drivers to allow software to write song data and control frequency cutoffs
 - Interrupts sent by hardware to ensure writes from software are timed correctly
- Software logic to read WAV files, processes input from a keyboard, and do some audio processing

Hardware

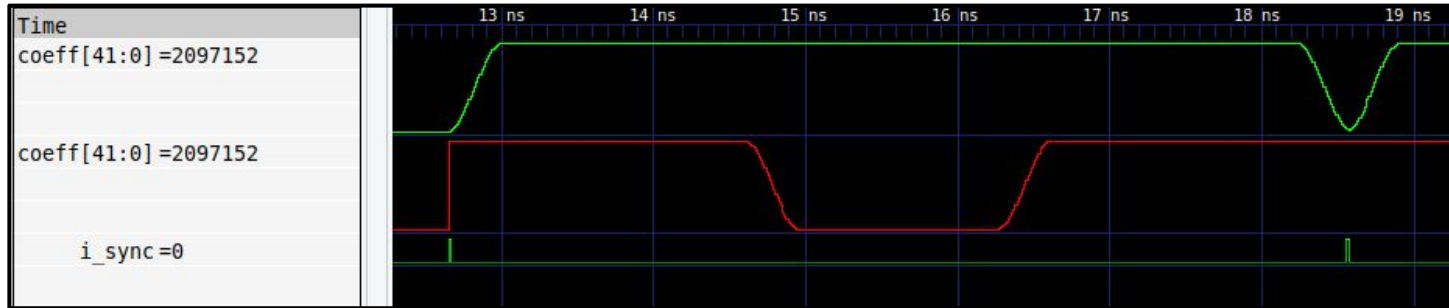


Pipelined FFT/IFFT

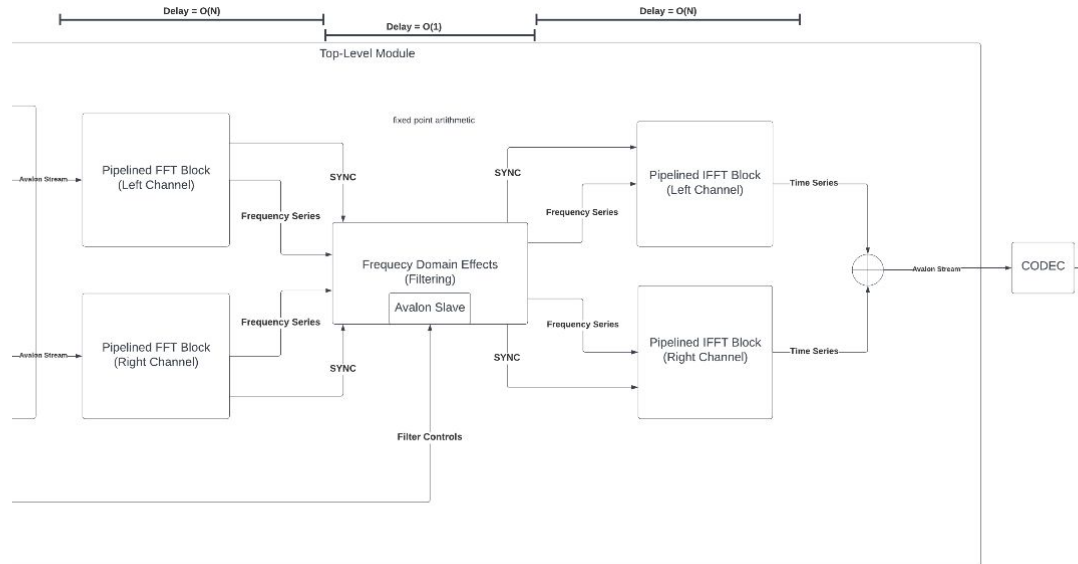


Hardware Effects - Frequency Domain

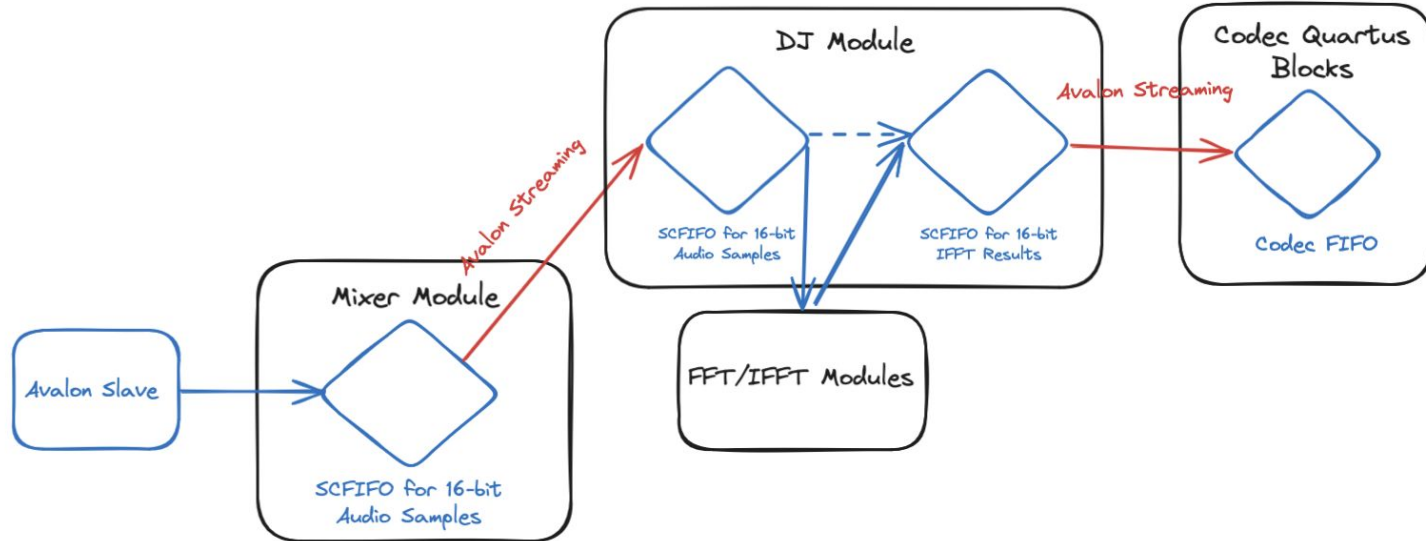
Filtering



Frequency Domain Effects Hardware Architecture



Audio Interface



Hardware-Software Interface

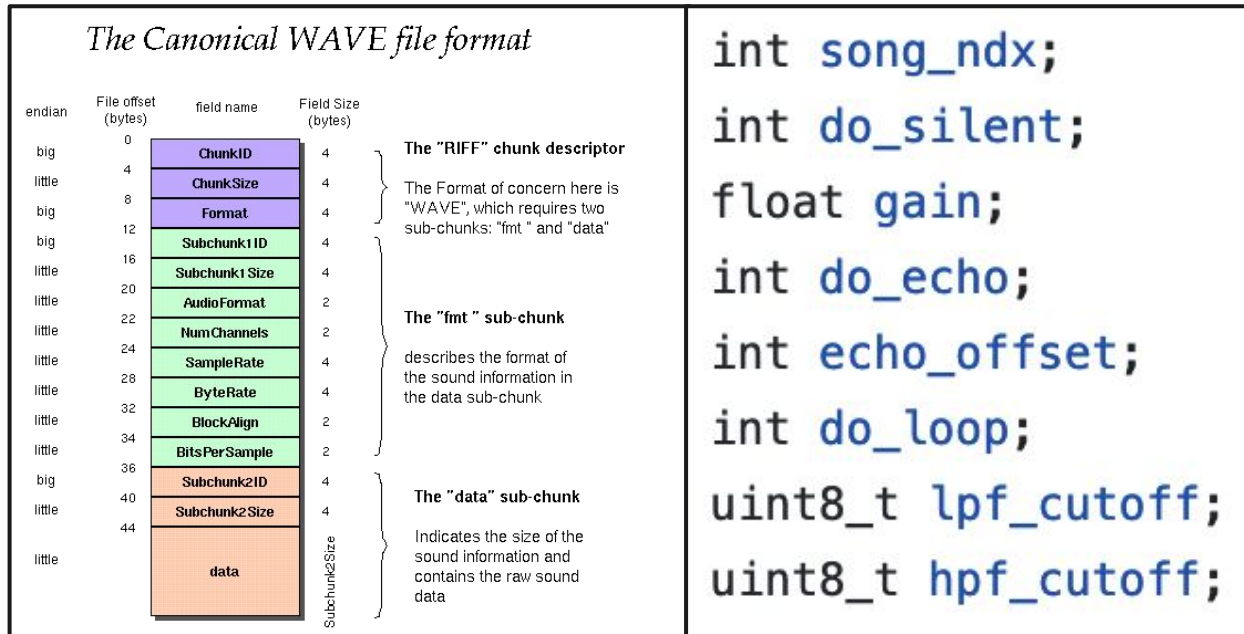


Use	Connections	Name	Description	Export	Clock	Base	End	IRQ
<input checked="" type="checkbox"/>		clk_0	Clock Source	clk	exported			
		clk_in	Clock Input	reset	clk_0			
		clk_in_reset	Reset Input	Double-click to				
		clk	Clock Output	Double-click to				
		clk_reset	Reset Output	Double-click to				
<input checked="" type="checkbox"/>		hps_0	Arria V/Cyclone V Hard Proce...	hps_ddr3	hps_0_h2...			
		h2f_user1_clock	Clock Output	hps				
		memory	Conduit	Double-click to				
		hps_io	Conduit	Double-click to				
		h2f_reset	Reset Output	Double-click to				
		h2f_aw_clock	Clock Input	Double-click to	clk_0			
		h2f_aw_master	AXI Master	Double-click to	[h2f_aw_...			
		f2h_aw_clock	Clock Input	Double-click to	clk_0			
		f2h_aw_slave	AXI Slave	Double-click to	[f2h_aw_...			
		h2f_fw_aw_clock	Clock Input	Double-click to	clk_0			
		h2f_fw_aw_master	AXI Master	Double-click to	[h2f_fw_a...			
		f2h_irq0	Interrupt Receiver	Double-click to		IRQ 0		IRQ 31
		f2h_irq1	Interrupt Receiver	Double-click to		IRQ 0		IRQ 31
<input checked="" type="checkbox"/>		mixer_0	Mixer	mixer				
		clock	Clock Input	Double-click to	clk_0			
		reset	Reset Input	Double-click to	[clock]			
		mixer	Conduit	Double-click to	[clock]			
		avalon_slave_0	Avalon Memory Mapped Slave	Double-click to	[clock]	# 0x0000_0000	0x0000_000f	
		avalon_streaming_source_right	Avalon Streaming Source	Double-click to	[clock]			
		avalon_streaming_source_left	Avalon Streaming Source	Double-click to	[clock]			
		interrupt_sender	Interrupt Sender	Double-click to	[clock]			
<input checked="" type="checkbox"/>		dj_0	DJ					
		left_ffo_source	Avalon Streaming Sink	Double-click to	[clk]			
		right_ffo_source	Avalon Streaming Sink	Double-click to	[clk]			
		reset	Reset Input	Double-click to	[clk]			
		clk	Clock Input	Double-click to	clk_0			
		codec_left_ffo_sink	Avalon Streaming Source	Double-click to	[clk]			
		codec_right_ffo_sink	Avalon Streaming Source	Double-click to	[clk]			
		effects1	Avalon Memory Mapped Slave	Double-click to	[clk]	# 0x0000_0080	0x0000_00bf	
<input checked="" type="checkbox"/>		audio_and_video_config_0	Audio and Video Config	audio_and_video_c...				
		clk	Clock Input	Double-click to	clk_0			
		reset	Reset Input	Double-click to	[clk]			
		avalon_av_config_slave	Avalon Memory Mapped Slave	Double-click to	[clk]	# 0x0000_0020	0x0000_002f	
		external_interface	Conduit	Double-click to				
<input checked="" type="checkbox"/>		audio_0	Audio					
		clk	Clock Input	Double-click to	clk_0			
		reset	Reset Input	Double-click to	[clk]			
		avalon_left_channel_source	Avalon Streaming Source	Double-click to	[clk]			
		avalon_right_channel_source	Avalon Streaming Source	Double-click to	[clk]			
		avalon_left_channel_sink	Avalon Streaming Sink	Double-click to	[clk]			
		avalon_right_channel_sink	Avalon Streaming Sink	Double-click to	[clk]			
		external_interface	Conduit	Double-click to				
<input checked="" type="checkbox"/>		audio_pll_0	Audio Clock for DE-series Boar...	audio_0_external.L...				
		ref_clk	Clock Input	Double-click to	clk_0			
		ref_reset	Reset Input	Double-click to	[clk]			
		audio_clk	Clock Output	Double-click to	audio_pll_0_audio...			
		reset_source	Reset Output	Double-click to				

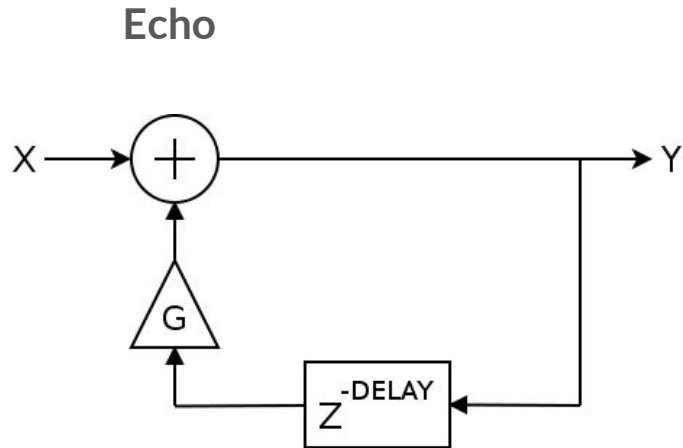


Software 

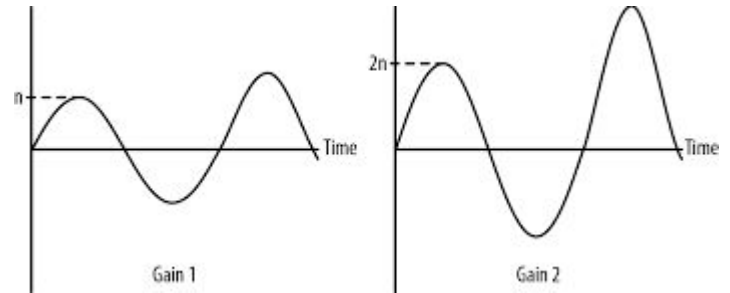
Software



Software Effects - Time Domain

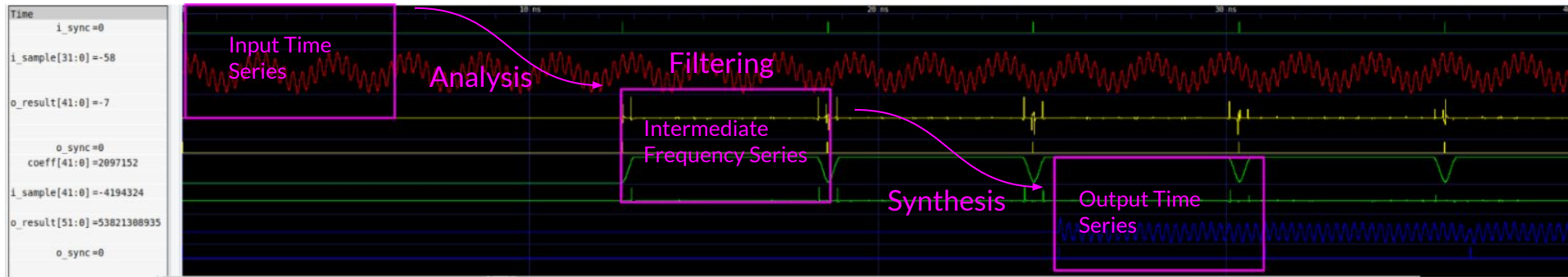


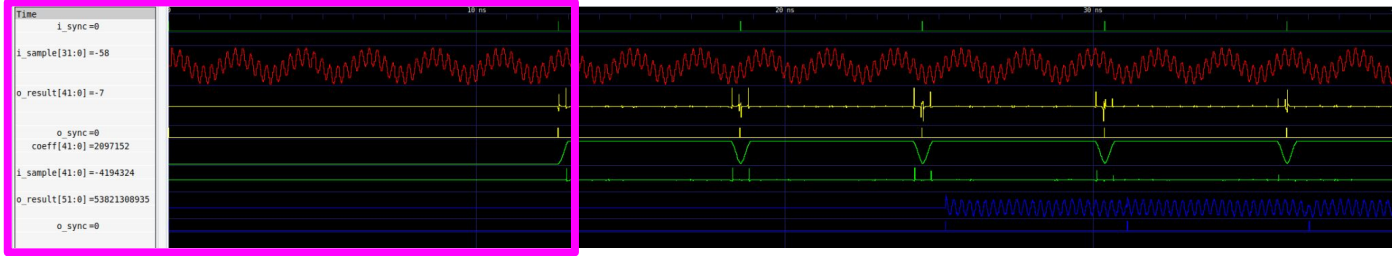
Gain



Validation and Testing 🤔

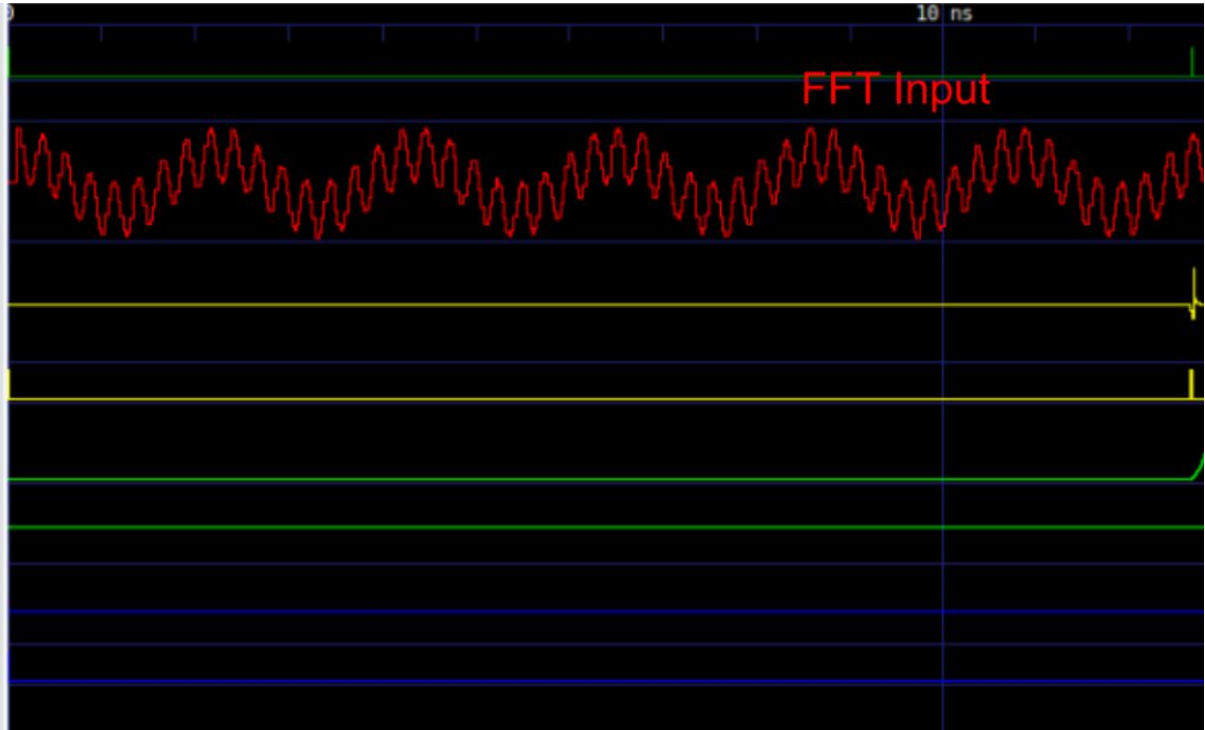
Simple Filtering Test





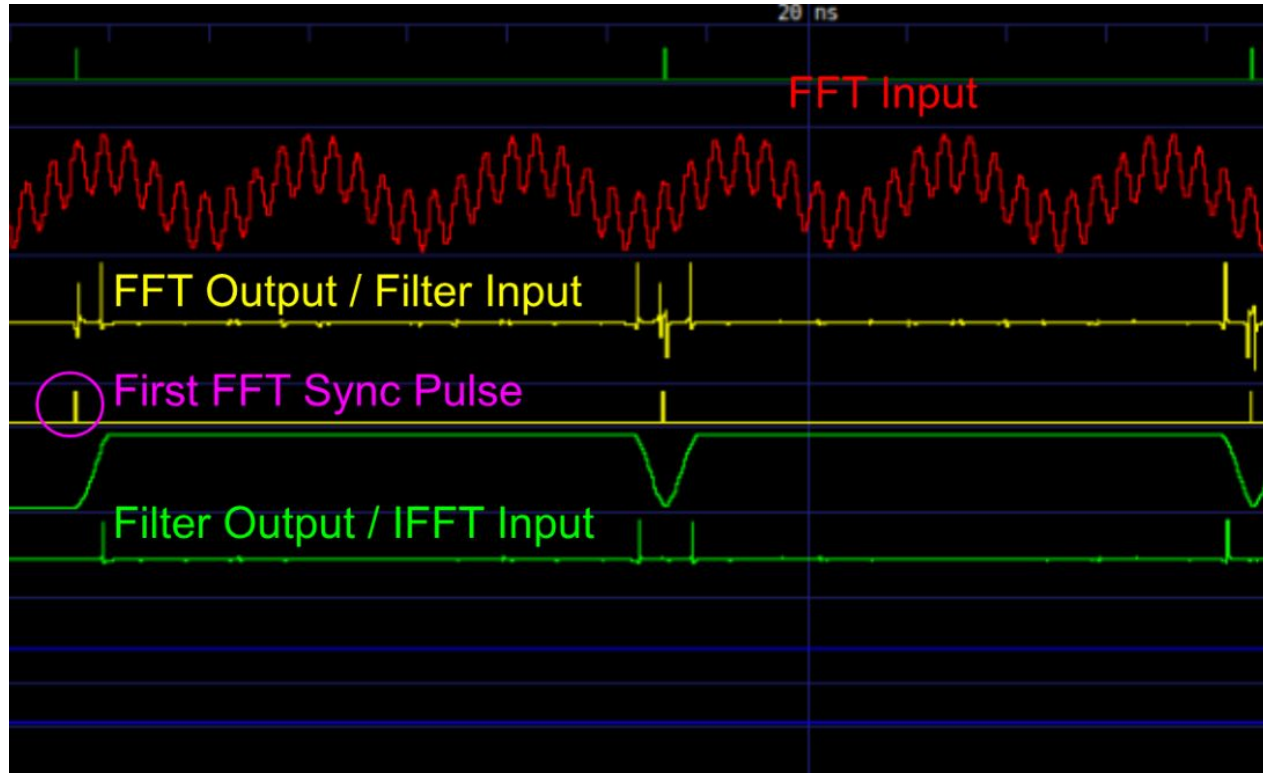
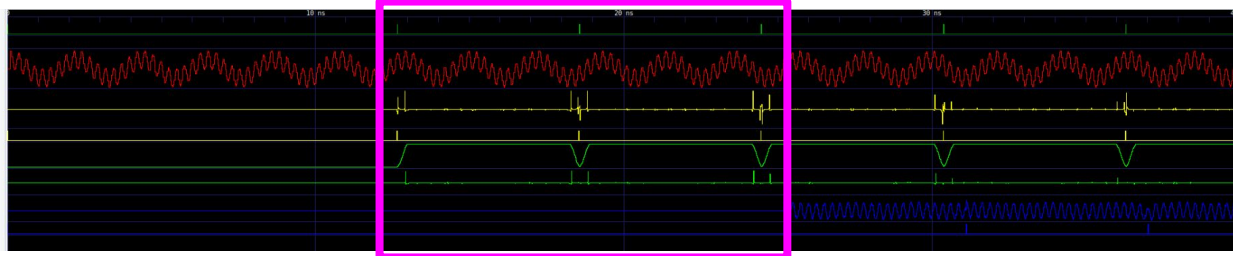
Time

- i_sync = 0
- i_sample[31:0] = -58
- o_result[41:0] = -7
- o_sync = 0
- coeff[41:0] = 2097152
- i_sample[41:0] = -4194324
- o_result[51:0] = 53821308935
- o_sync = 0



```
Time
  i_sync=0
i_sample[31:0]=-50
o_result[41:0]=-7

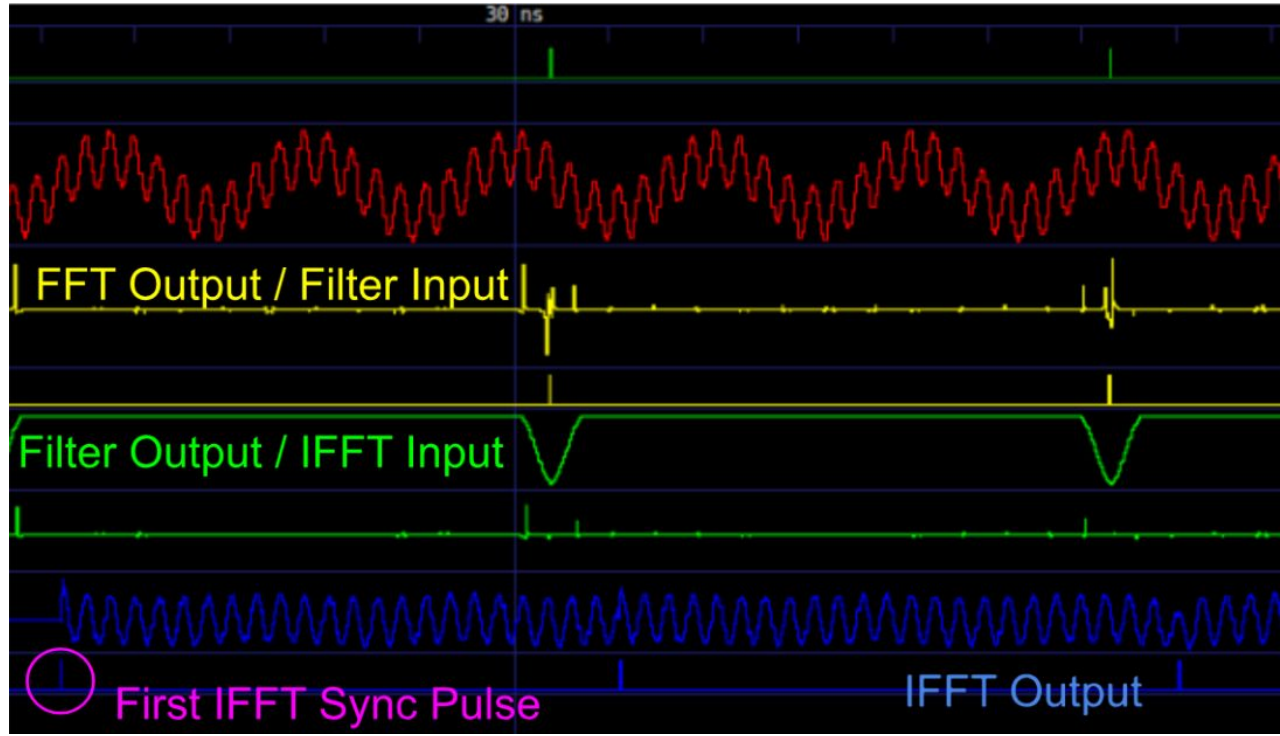
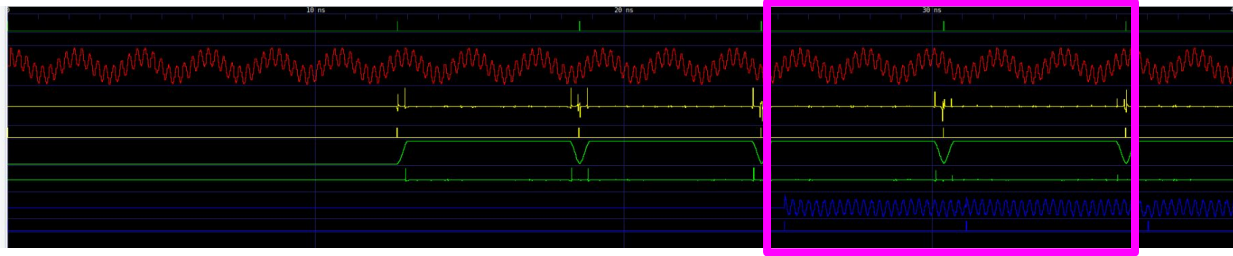
  o_sync=0
coeff[41:0]=2097152
i_sample[41:0]=-4194324
o_result[51:0]=53021308935
  o_sync=0
```




```
Time
  i_sync=0
i_sample[31:0]=58
o_result[41:0]=-7

  o_sync=0
coeff[41:0]=2097152
i_sample[41:0]=-4194324
o_result[51:0]=53821388935

  o_sync=0
```





Demo





(0 _____ 0)